



DOI: 10.22363/2312-797X-2018-13-4-303-316

RADIATING PATHOLOGY IN AGRICULTURAL ANIMALS WITH A DISEASED THYROID GLAND

S.A. Pavlova

Department of environmental management and environmental protection
of the Russian Presidential Academy of National Economy
and Public Administration (RANEPA)
Moscow, 119571, Russian Federation
s_pavlova@mail.ru

Abstract. Radioactive iodine is present in atmospheric fallout during the first hours of accidental emissions at nuclear power plants. It causes damage to the thyroid gland of varying severity. As a result of lesions with radioactive iodine, pathological changes develop in the thyroid gland, which can affect the productive indicators and reproduction of farm animals. Physiological changes are also diagnosed in animals that do not receive a sufficient amount of iodine compound with food or water. This can lead to pathology of the thyroid gland. Studies of the pathology of the thyroid gland should be carried out on the basis of structural modeling methods and data obtained experimentally. Analysis of the comparison of pathological effects allows to systematize information and use it in scientific and practical purposes.

Depending on the intensity and duration of external and internal radiation exposure in farm animals acute or chronic radiation diseases can be diagnosed. Farm animals with or without signs of radiation disease of mild severity are left in farms and used for its intended purpose. Long-term effects of radiation can be manifested as temporary or permanent sterility, metabolic and endocrine status disorders, immunodeficiency, increased sensitivity to infectious diseases, the emergence of tumors. Monitoring of the radiological situation on the territory of the livestock complex is of particular importance, as its products are transported to different regions. Livestock products must meet regulatory requirements. Timely and full implementation of general and specific rules in the field of radiation safety is aimed at ensuring the safety of animals and preserving the quality of animal products.

Keywords: thyroid gland, radiating pathology, farm animals, modeling

INTRODUCTION

In 1986, as a result of the Chernobyl accident, a significant part of Belarus, Ukraine and part of the Russian Federation were affected by radionuclide contamination. The problem of radiation exposure to farm animals was studied before the Chernobyl accident, thus a large experimental material was already collected, which allowed to diagnose radiation pathology of the thyroid gland of different severity [1—4]. Scientific fundamentals of diagnosis, methods of maintenance and therapy were in demand after the Chernobyl accident [3, 5—9].

MATERIALS AND METHODS

The aim of the study was to systematize the data of radiobiological studies obtained as a result of irradiation of sheep and physiological parameters in cattle, which were in the area of radioactive contamination and evaluate the productivity of irradiated animals.

Material for the study:

1. The experimental data obtained following exposure of different doses to sheep.

Under experimental conditions, the conditions of radiation exposure were set and the dose dependence was determined. Experiments were conducted on the basis of Federal Center for Toxicological, Radiation, and Biological Safety — All-Russian Research Veterinary Institute (FCTRBS-ARRVI, Kazan). For simulation of radiation exposure in experiments on sheep, internal Iodine-131 irradiation (single or multiple), external gamma irradiation and combined external gamma irradiation with Iodine-131 or with a three-component mixture of melted radioactive particles were used as a radiation factor. Priming with iodine was carried out in the morning before feeding, in the form of an aqueous solution of potassium iodide without a carrier, into the esophagus using a polyvinyl tube and a syringe, daily in equal portions for 30 days or once, on the basis that the greatest intake of it with food in the “young” fission products is noted in the first 30 days after falling out on the terrain. Doses were selected according to the norms of contamination of feed by “young” fission products and norms of feed consumption by sheep.

Sheep were given contaminated with radioactive Iodine-131 through feed, the doses and conditions were different:

1.5 microcurie/kg\days' 30

4.5 microcurie/kg\days' 30

45 microcurie/kg\days' 30

45 microcurie/kg\days' 30

450.0 microcurie/kg\l days'

1.0 microcurie/kg

300 x-rays (γ)

600 x-rays (γ)

1000 x-rays (γ) + hunger (7 days')

300 x-rays + 4,5 microcurie/kg\day 30 days'

600 x-rays + 1 microcurie/kg\day + fasting 7 days

1.0 microcurie/kg\day +7 day fasting

Study material: wool; blood (hematological and biochemical parameters); thyroid hormones. The immunological status and reproduction indices were also studied.

2. Information obtained during monitoring on the radioactively contaminated territory of Belarus. Cows were examined after irradiation with doses 27—29 krad and 16—18 krad at the farm «Strelichevo» in Hoyniksky region.

Methods:

Experiment. The functional activity of the thyroid gland in sheep was assessed by the ability of serum proteins (α - and β -globulins) to bind exogenous thyroxine labeled with radioiodus-125 during electrophoretic separation on paper tapes. Indicator-1/F assesses the functionality of the thyroid gland and indicates a direct relationship: its high rates indicate high activity of the gland; low rates indicate low activity.

Methods of system analysis. A block approach was used for system analysis of information. The information was analyzed in accordance with the structural scheme.

Methods of logic and information modeling. Using the methods of system analysis and modeling, the radiobiological parameters of cattle located on the territory of livestock complexes in the Gomel region were studied.

RESULTS AND DISCUSSION

Radioactive Iodine is present in atmospheric deposition in the first hours of accidental emissions at nuclear power plants. It causes thyroid lesions of varying severity. The thyroid gland is a part of the neuro-hormonal regulation system. As a result of radioactive iodine damage, pathological changes develop in the thyroid gland, which can be manifested as a result of direct irradiation of the exocrine epithelium and mediated — through the hypothalamic-pituitary system. The damage of the thyroid gland causes a violation in the functional activity in other parts of the neuro-endocrine system. The changes have a phase character and are manifested as a compensatory-adaptive response to hormonal disorders because of radiation exposure. Changes in the metabolic activity of the thyroid gland are also diagnosed in farm animals kept in areas with low concentrations of stable iodine in soil and feed. Iodine pathology is diagnosed on the physiological level in affected animals (Fig. 1, Fig. 2). Endemic diseases of the thyroid gland are typical for Belarus. After the Chernobyl accident, it was necessary to determine what pathology of the thyroid gland and what methods of therapy should be used. On the basis of the designed structural and model schemes, information can be not only systematized, but also the cause of pathology can be modeled and identified (Fig. 1, Fig. 2).

Structural modeling

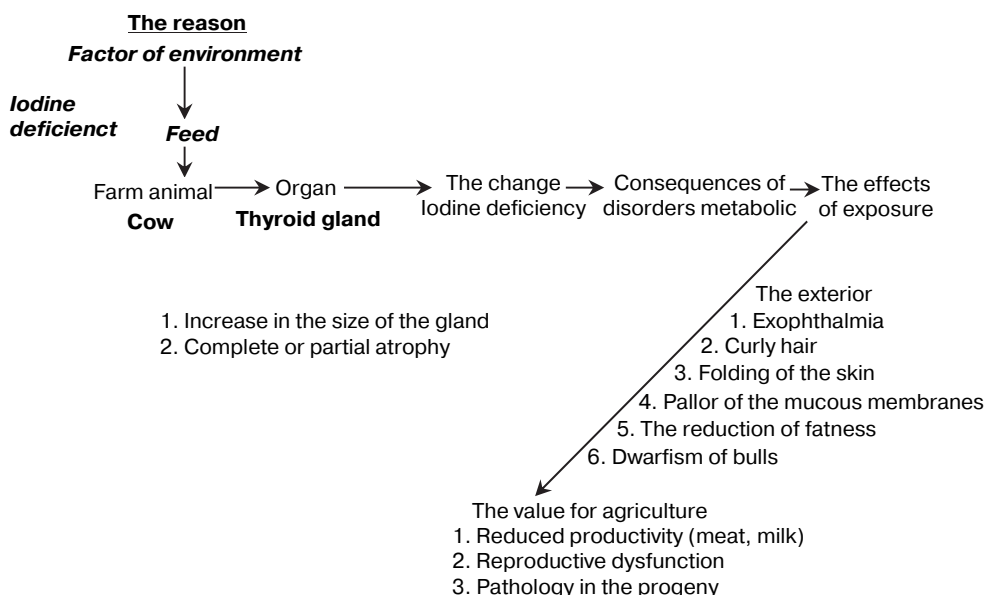


Fig. 1. Model structural scheme of the study of the effects of iodine deficiency in cattle

Environment factor

1. Iodine content

in soil < 0.00001%

in drinking water < 10 micrograms per liter

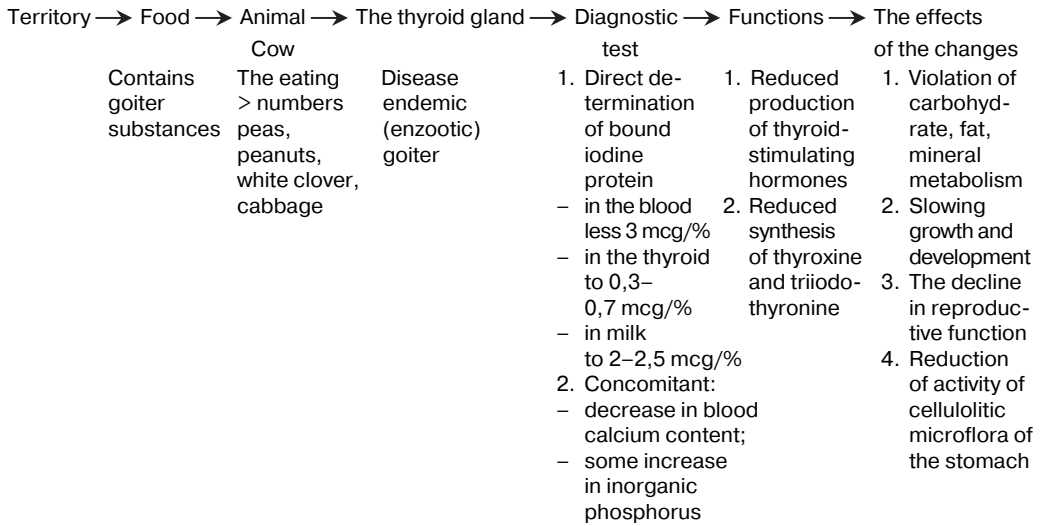


Fig. 2. Model structural diagram of the influence of iodine deficiency on the physiological indexes of agricultural animals

Results of studies of animals with affected thyroid gland

Chronic radiation disease, which is diagnosed in sheep with Iodine-131, develops slowly, early diagnosis of severity is difficult. When feeding with contaminated feed radiation pathology can be diagnosed in sheep, for example:

— if there is Iodine-131 microcurie 2.0 and above in a feed of the daily diet of adult sheep;

— in the first 10 days of feeding by more than 500 microcurie contaminated feed.

In farm animals diagnosed symptoms of general lethargy, increased intestinal motility, severe diarrhea. The decrease in appetite is observed in the first 5—15 days from the beginning of feeding with contaminated feed, and there is a significant decrease in body weight after 15—30 days. Subsequently, leuko-, lympho- and erythropenia is diagnosed.

Experimental studies on the kinetics of Iodine-131 in the thyroid gland were carried out in ARRVI, Kazan (Fig. 3) [1]. The kinetics of Iodine-131 in sheep in the critical organ depended on the dose and multiplicity of seeding. As a result of the conducted experiments, the dependence of the thyroid activity index on the effective dose was found and the peculiarities of their dynamics were determined (Table. 1, Table 2, Fig. 3). As a result, on the basis of experimental studies, changes in the functional activity of the thyroid gland in time for all acting doses were established. The optimal absorbed dose, causing thyroid tumor in experimental animals is 2.3...16.0 krad; minimum — 0.2 krad. During starvation in experimental animals there is a decrease in the activity of the thyroid gland. The dynamics of combined effect is similar to the dynamics during

starvation. In calf-bearing cows, there is an increase in thyroid activity at the current dose of 45 microcurie/kg\days' 30 for the entire duration of the study, which corresponds to chronic radiation disease of II severity. Reduced activity is diagnosed at a dose of 600 rad + 1 microcurie/kg\once a day for adults + 7 days of starvation, while developing an extremely severe degree of acute radiation disease for the period from 2 days to 15 days. Increases in activity of 15 days is noted with I degree of chronic radiation illness in influencing the dose of 4.5 microcurie/kg\day' 30. For the rest of the treatment doses that cause radiation disease is characterized by reduction in activity.

Experimental method in vitro

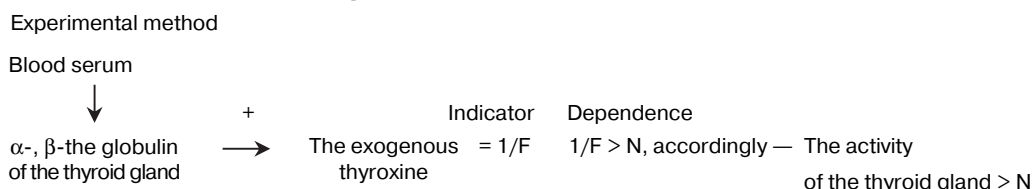


Fig. 3. Model scheme of studies increased functional activity of the thyroid gland in experimental research methodology

Table 1

Indicators of functional activity of the thyroid gland in vitro, irradiated by different doses: Iodine-131 — seed (inter), 300 x-ray radiation dose and 600 x-ray radiation dose — external gamma-irradiation of sheep, in indicator of 1/F (description N — an indicator of the physiological norm)

Dose Type Duration Organism	Min	N (norm)	Tendency	Effects of radiation. Degree of radiation disease
1.5 microcurie/kg\days' 30 chronic 30 days' lambs (5—6 months')	30 days'	no data	15 days' ← to 30 days' → increase up to control to 1.5—2 months'	3—5 months' — oscillation < N 9—12 months' > N Chronic, I degree
4.5 microcurie/kg\days'30 chronic	outcome	no data	15 days' → (→1.5 years)	> N Chronic, II degree
45 microcurie/kg\days' 30 chronic adults	outcome	no data	← to 1.5 months' For all. 3 months' >N; 4 months' N; 5—9 months' >N	Chronic, II degree
45 microcurie/kg\days' 30 chronic pregnant	4 months'	no data	1.5 years ←. outcome > N; 2 months' > N; 3 months' > N; 4 months' < N; 5—9 months' > N; 1.5 years ←	4 months-abortion and non-viable lambs
450.0 microcurie/kg\day chronic adults	3 months' (<< N in 3 times more)	outcome	← with the outcome	< N
1.0 microcurie/kg singly adults	2 days'		> N outcome ← from 2 days' → to 15 days' >> N	>> N 15 days' An acute severe disease
300 x-rays (γ) adults	6 months' < N	1.5 months' N	← from 2 months' to 6 months' → to 9—12 months' to N	N lower control limits. An acute illness of moderate severity

Table 1 (continued)

Dose Type Duration Organism	Min	N (norm)	Tendency	Effects of radiation. Degree of radiation disease
600 x-rays (γ)	2 days' (> N)	to 15 days'	≈ N to 15 days'	Individual differences are characteristic. An acute illness, severe severity
1000 x-rays (γ) + hunger (7 days') adults	5 days'	no	← from 2 days' to death < N ← from 2 days', from 15 days' →	Death 13 days' increase < N ≈ control, < outcome's an acute illness of moderate severity
300 x-rays + 4.5 microcurie\kg\day 30 days' adults	The end of the experiment	no	← from 15 days' (in 2—2.5 more); ← 4—5 months', → from 6—9 months' to control	< N An acute illness of moderate severity
600 x-rays + 1 microcurie\kg\day single adults + fasting 7 days	2 days'	no	→ from 2 days' to 15 days' → with days' (in 2 more)	< N An acute illness, extremely severe disease
To 1.0 microcurie\kg\day +7 day fasting adults	End of the experiment	no	← with 2 days' 2 times more from twice the outcome to the end (in 3.1 more)	< N An acute illness, severe degree
<i>Conclusion:</i> there are temporal dynamics of the activity changes at all dose levels; fasting — lowering activity (decrease in metabolism).				
<i>Designations:</i> 1/F-index reflecting the activity of the thyroid gland, the more 1/F, the higher the activity. ← — decreasing trend from normal (control) N; → — increase				

Table 2

The absorbed thyroid dose β-, γ-radiation of Iodine-131 at 30-day introduction of isotopes of the sheep in the experiment

The dose of iodine-131	The radiation disease	Absorbed thyroid gland dose (rad)
1.5 microcurie\kg ·30 days	Chronic radiation disease of I degree of severity	8 138 ± 236
4.5 microcurie\kg ·30 days	Chronic radiation disease of I degree of severity	14 814 ± 849
45 microcurie\kg ·30 days	Chronic radiation disease of II degree of severity	25 673 ± 1090
450 microcurie\kg ·30 days	Chronic radiation disease of III degree of severity	29 346 ± 1640
300 x-rays + 4,5 microcurie\kg 30 days	Acute radiation disease of moderate severity	4 812 ± 773
300 P+45 microcurie\kg 30 days	An acute radiation disease of severe degree of severity	28 948 ± 2414

Metabolic features

The decrease in thyroid activity is recorded for high doses and in chronic radiation disease of II and III severity [6, 7, 9, 10]. Features of the functional activity of the thyroid gland depend on severity of radiation disease.

1. Chronic radiation disease of I degree of severity is characterized by increased activity of the gland in lambs and sheep. After 1.5—2 months young indicators of thyroid activity in the contaminated farms are above the control. After 2 years, there was a decrease, and then again an increase in activity.

2. Chronic radiation disease of the II degree of severity: there was instability of activity in the first 2 months, depression with increased activity in the next 7 months and a sharp decline after 1.5 years.

3. Chronic radiation disease of the II degree of severity: a decrease in activity below control until the end of life.

It was determined that small doses cause increased activity, and large — inhibition of activity and destruction of organ parenchyma. On the basis of experimental data, it was found that at high acting doses, a decrease in the sensitivity of the nervous system is characteristic, which is diagnosed as an extension of the latent reflex time. At the same time, there is a decrease in productive indicators (Table 3).

Table 3

Indicators of biological effectiveness of Iodine-131 in a dose dependent manner

The dose of iodine-131	The radiation disease	Absorbed thyroid gland dose (rad)
1.5 microcurie\kg ·30 days	Chronic radiation disease of I degree of severity	8 138 ± 236
4.5 microcurie\kg ·30 days	Chronic radiation disease of I degree of severity	14 814 ± 849
45 microcurie\kg ·30 days	Chronic radiation disease of II degree of severity	25 673 ± 1 090
450 microcurie\kg ·30 days	Chronic radiation disease of III degree of severity	29 346 ± 1 640
300 x-rays +4.5 microcurie\kg ·30 days	Acute radiation disease of moderate severity	4 812 ± 773
300 x-rays +45 microcurie\kg ·30 days	An acute radiation disease of severe degree of severity	28 948 ± 2 414

Radiation has a direct and indirect effect on the activity of the nervous system and the processes of regulation. The experiments on sheep determined [1]:

1) chronic radiation disease of I degree of severity: 1.5 months after seeding, there is a significant acceleration of defensive unconditional reflex reaction;

2) acute radiation disease of moderate severity: unreliable acceleration of defensive unconditional reflex reaction;

3) with all other degrees of severity of acute and chronic radiation disease, there is a slowdown in the unconditional reflex reaction.

The depth and severity of violations directly depends on the dose. With relatively small doses, an increase in the sensitivity of the nervous system is recorded. In the studied animals there are no changes in the productive indicators.

The diagnosed features of hormonal dynamics in cows with radiation damage of thyroid Iodine-131 may be associated with changes in other physiological systems [9]:

1) hematological parameters: no profound changes. In the radiosensitive system of erythroid hematopoiesis, a decrease in the number of erythrocytes is diagnosed and their dose dependence in individual individuals is weakly expressed;

2) the system of hemostasis: activation of coagulation secondary link and the primary inhibition of vascular-platelet link;

3) changes in the level of cyclic nucleotides in blood plasma: more pronounced in the spring and less pronounced in healthy cows in the “clean” area, systematically receiving alcohol-containing feed;

4) hormonal parameters: decrease in the level of T4 and T3 and disturbances in interhormonal relationships, as well as seasonal variability and a significant increase

in the content of biologically active free fraction of cortisol due to a decrease in the binding capacity of blood proteins. The dose direct dependence of changes in the level of T4, T3, insulin and cortisol is determined, the dependence is direct — the higher the dose, the greater the change;

5) Changes in the hormonal status of cows with radiation damage to the thyroid gland cause disorders in the reproductive system (Table 5). In the first group of cows that received a large dose to the thyroid gland in the polluted farms of the Gomel region there is a decrease in reproductive capacity:

- a) reduced the index of impregnation capacity (in 1987),
- b) reduction of service period duration.

For example, the duration of the service period by day in 1987 increases, and by 1989 in the studied farms decreases, i.e. shortens.

Reproductive performance

The account of reproductive indicators for farm animals is very important for any animal husbandry, and for those who are in the pollution zone they are of particular importance. To calculate the index of reproduction (I_v) for one individual, the calculation of the average value for the lifetime of the individual can be used:

$$\sum I_v = \frac{\sum F_i}{\sum P_j}, \quad (1)$$

where F_i — the offspring (lambs); P_j — the sheep that produces its offspring.

$\sum I_v$ — can be calculated for a group of individuals both for the year and for the time of observation or life of individuals of the group. Statistical research methods can be applied:

- for carrying out the dispersion analysis between the values of indicators of individuals in the group, under the action of different doses of radiation on them;
- determination of the confidence interval between different indicators of individuals, groups of individuals and indicators of their reproduction, etc.

Time component accounting

The time component is taken into account when studying the time dynamics of both individuals and individuals in the group. At the same time the season, exposure factors, physiological time, etc. can be seen. In the system information analysis time allows to systematize the information considering the time of the study or the time period of the diagnosed changes.

Time dynamics

The change of indicators in time reflects the time dependence of changes in the studied parameters on the physiological norm and characterizes the stage of development of pathology (Table 4).

Table 4

Time dynamics of change of indicators from physiological norm of the hormonal status on groups cattle of the Gomel area: Hojniksky area (2nd pollution degree) I, II group of cows and offspring; state farm Oktyabrskaya of Oktyabrsky (district control) cows

Year	Quarter	Cows I group (2 nd pollution degree)	Bulls (86 year of birth) from I group	Heifers from I group	Cows II group (2 nd pollution degree)	Cows (4 th pollution degree)
Triiodothyronine (T3) (nmol/l)						
1987	II	< N, N, > N				
	III	< N, N		< N		
	IV	< N, N				< N, N, > N
1988	I	< N, N, > N		< N		N
	IV	< N, N, > N	> N			< N, N, > N
1989	I	< N, N, > N	N			< N, N
<i>Result:</i> Changes in the values of the indicator are recorded in groups of cows from farms in all study periods; in young animals there is a decrease in heifers from cows of group I.						
Thyroxine (T4) (nmol/l)						
1986	IV	> N				
1987	II	< N, N, > N		N	< N, N	
	III	< N, N, > N		N	< N, N	IV quarter < N, N
1988	I	< N, N, > N		N	< N, N	< N
	IV	< N, N, > N	> N		> N, N	N, > N
1989	I	< N, N, > N	< N		< N, N	< N, N
	II	< N, N, > N		> N	< N, N IV quarter < N, N, > N	< N, N
<i>Results:</i> Greatest changes are observed in groups of cows in all study periods; for young animals, the values are reduced in bulls in the first quarter of 1988.						
<i>Conclusion:</i> Dynamics in the values of the indicator relative to the norm is typical for cows, for young recorded some deviations, mainly in the group of heifers of group I.						

Physiological indices in the exposed cows from contaminated farms

At the farm “Strelischevo” Hojniksky district study of cows affected with thyroid revealed some peculiarities [9, 10].

Indicators of immune status:

— No significant differences in the level of infection were found.

— The concentration of lysozyme in the blood serum in the summer was below the control values.

In cows that received a dose of 27—29 krad, the concentration of lysozyme in serum decreased by 24%, and in those who received a lower dose (16—18 krad) by 35% — an inverse dependence on the dose.

— Bactericidal activity of blood serum: in group I cows it was at a sufficiently low level ($26.4 \pm 5.6\%$) (< N), and in group II it was higher (> N).

— Immunological response to A₂₂/C₁ anti — vaccination (IV quarter 1988) — positive, but the temporal dynamics is poorly expressed.

Studies of reproductive and productive indicators of irradiated animals have shown that the most pronounced changes in them are diagnosed in farm animals:

- with a higher absorbed dose in the thyroid gland;
- consuming contaminated feed;
- located in an area with a higher density of pollution.

Comparative analysis of productivity in the polluted farm “Vysokoborsky” in Vetkovsky district (the maximum degree of pollution) and the Collective Farm of First of May, Chechersky district, where the animals were fed for 3 years after the accidental release of contaminated feed above $1.0 \cdot 10^{-6}$ Curie/kg, showed that in the long term, 4 years after the accident, there is a restoration of reproductive function and reproductive performance in cows, including cows with signs of thyroid damage (Table 5).

The calculation of the coefficients relative to the physiological norm

The conducted researches were based on comparison of the diagnosed sizes with sizes of physiological norm. The comparison analysis revealed a number of differences, which are reflected in Table 5.

Table 5

The degree of priority of the indicators (maximum of the diagnosed values in the group) of thyroid hormones on the physiological norms for the groups of cattle Hoyniksky district (2nd degree of pollution)

Year	Quarter	Triiodothyronine (T3) (nmol/l)			Thyroxine (T4) (nmol/l)			Bulls from I group cows (born in 1986) (from N)		Sum Indicators' per quarter
		< N	> N	N	< N	> N	N	T3	T4	
1987	II	2	3	1	2	3	1			6 + 6
	III	1	3(0)	2	2	3	1			3 + 6
	IV	1	3(0)	2						3 + no data
1988	I	2	3	1	2	2	1			6 + 5
	IV	1	3	2	1	1	1	> N	> N	6 + 3
1989	I	1	3	2	2	3	1	N	N	6 + 6
1989	II				1	3	2			no data + 6
<i>Conclusion:</i> the spread of values from the norm. (3 (0) — the value was diagnosed, but it is 0)										

Offspring obtained from cows with radiation damage to the thyroid gland are diagnosed with abnormalities [9]:

- 1—2 calves monthly changes in coagulogram — hypercoagulability;
- increase in the level of cyclic nucleotides by 1.9—1.5 times;
- decrease in the level of red blood cells;
- platelet content 2 times higher than the control;
- bactericidal activity of serum in young animals obtained from cows of group I — at a high level (> N): bulls 50.0%; heifers 44.6%; calves 66.6%;
- the dynamics of hormonal parameters does not indicate pathological changes;
- the main causes of mortality of calves received from cows with signs of radiation damage to the thyroid gland (I, II groups): dyspepsia; bronchopneumonia. Calves of first generation (F1) 1989 year birth lagged behind in growth — bulls dwarfs, but in the

future, they gained height and weight, reaching a weight of 400 kg. Cows were resulting offspring in 1990. Calves born in 1990 (F2) from cows born in 1987 did not differ in their physiological development from young control and non-polluted farms, dominated by heifer. 30% of all livestock received in 1989—1990 were bull-calves;

— hormonal parameters in offspring obtained from cows with varying degrees of radiation damage to the thyroid gland, deviate from the norm. Steers were characterized by the excess rates of T3 and T4 in the first quarter of 1989. Heifers had a decrease below normal in the second quarter of 1987 and in the first quarter of 1989 because of incomplete data and the lack of a temporal chronology of diagnosis, based on their changes obtained from the cows and the dose can not be determined.

Studies of the temporal annual variability of the average indicators of triiodothyronine and thyroxine indicate deviations from the norm. In cows of I group, for example, in 1987, in the period from the II quarter to IV, an increase in triiodothyronine was diagnosed, but below the norm ($<N$). At the same time, the minimum values of deviation from the norm, as well as the detected elevated triiodothyronine values fall above the norm. For thyroxine in the same period, the maximum values (average for the group) are observed for the group — more than the norm ($>N$), and the minimum values — norms (N).

The results of statistical studies revealed deviations from the physiological norm of hematological parameters in heifers (born in 1987) from the I group of cows with affected thyroid farm «Strelchevo» of Hoyniksky district (2nd degree of pollution) [7, 8]. Deviations were determined in the autumn.

The results of the diagnosis of biochemical blood parameters indicate their deviations from the physiological norm in the offspring obtained from cows with irradiated thyroid gland. In General, according to the diagnosed indicators in the offspring obtained from the I group of cows, it is noted:

— for bulls born in 1986 had a decrease relative to the norm;
— for calves — a small prevalence above the norm, but there is a decrease relative to the norm.

For groups of cows (I and II group) in total, there is a more pronounced decrease in biochemical parameters in the group that received a large dose to the thyroid gland. Biochemical indicators can be informative at radiation pathology, therefore it is necessary to carry out their diagnostics systematically on different age groups of farm animals, in comparison of producers and their posterity.

A comparative analysis of productivity in the polluted state farm “Vysokoborsky” of Vvetkovsky district (the highest degree of pollution) and on the Collective Farm of First of May of Chechersk district, where animals were fed for 3 years after the accidental emissions by contaminated feed above $1.0 \cdot 10^{-6}$ curie/kg, showed that in the long term, 4 years after the accident, there is a positive trend towards the restoration of reproductive function and reproductive performance in cows with signs of thyroid damage.

CONCLUSIONS

To assess the state of the endocrine system of farm animals located in the contaminated area, it is necessary to consider seasonal and age-specific dynamics of hormonal parameters by age groups and acting doses. Changes in endocrine parameters entail

changes in other physiological parameters. For livestock management in contaminated areas, it is important to know how these changes will affect the reproductive and productive features of farm animals.

The most pronounced pathological changes after the Chernobyl accident were diagnosed in farm animals left in polluted farms. They were also diagnosed in cows with an affected thyroid gland. In offspring obtained from cows with the highest dose of thyroid radiation, deviations from the physiological norm were most pronounced in the first generation, and in the second generation of pathology was not noted.

When exposed to radioactive Iodine, thyroid damage is diagnosed, which is the greater the dose absorbed by the gland. It was determined that there are more pronounced the pathology of the thyroid gland, more pronounced the changes in physiological parameters and decrease of reproduction and productivity in farm animals.

Studies of reproductive qualities and productive indicators of irradiated animals showed that the most pronounced changes were diagnosed in farm animals that were on the territory with a higher density of pollution and with a higher absorbed dose in the thyroid gland.

It is advisable to carry out studies to identify changes in hematological, biochemical and hormonal parameters systematically in groups of farm animals, taking into account the radiation background of the area and livestock premises, the degree of contamination of feed. Comparative data analysis is necessary to identify dependencies and patterns. It should be carried out on different groups of farm animals exposed to different doses of radiation on the basis of methods of system analysis and modeling. The use of methods of system analysis and modeling allows not only to systematize the material of research and diagnosis, but also to predict the situation in the livestock complex.

© Pavlova Svetlana Anatolevna, 2018

REFERENCES

1. An estimation of consequences of radiating defeat of sheep and conducting sheep breeding in the conditions of radioactive pollution of territory. *Methodical recommendations for listeners ATF for SE direction*. Kazan; 1984. (In Russ).
2. Il'enko AI. *Problemy i zadachi radioekologii zivotnykh* [Problems and tasks of animal radioecology]. Moscow: Science Publ.; 1980. (In Russ).
3. Prister BS. *Problemy sel'skokhozyaistvennoi radiologii: sbornik nauchnykh trudov* [Problems of agricultural radiology: collection of proceedings]. Vol. 4. Kiev: UNIISP Publ.; 1996. (In Russ).
4. Ilyin LA. *Radioaktivnyi iod v probleme radiatsionnoi bezopasnosti* [Radioactive iodine in a problem of radiating safety]. Moscow: Atomizdat Publ.; 1972. p. 272. (In Russ).
5. Obaturov GM. *Biofizicheskie modeli radiobiologicheskikh effektov* [Biophysical models of radio biological effects]. Moscow: Energoatomizdat Publ.; 1987. (In Russ).
6. Kirshin VA, Bobryshev KP, Budarkov VA, Gusarova ML, Zhukov EG, Zelenov YN. *Radiatsionnye efekty u zivotnykh* [Radiating effects in animals]. Moscow: MSVMB Publ.; 1999. (In Russ).
7. Iljazov RG, Aleksahin RM, Korneev NA, Sirotkin AN. *Radioekologicheskie aspekty zivotnovodstva (posledstviya i kontrmery posle katastrofy na Chernobyl'skoi AES)* [Radio ecological aspects of animal industries (consequences and counter-measures after accident on the Chernobyl atomic power station)]. Gomel: Polesptchat Publ.; 1996. (In Russ).

8. Romanov GN. *Radioekologicheskie otsenki posledstviy avarii na Chernobyl'skoi AES dlya territorii 30-km zony i USSR* [Radio ecological estimations of consequences of failure on the Chernobyl atomic power station for territory of 30-km of a zone and USSR]. Research report. 1987. (In Russ).
9. Sirotkin AN, Iljazov RG. *Radioekologiya sel'skokhozyaistvennykh zhivotnykh* [Radioecology of agricultural animals]. Kazan: FEN Publ.; 2000. (In Russ).
10. Loshchilov NA. *Problemy sel'skokhozyaistvennoi radiologii. Sbornik nauchnykh trudov* [Problems of agricultural radiology. The collection of proceedings]. Kiev: UNITEI and UNIISP Publ.; 1992. (In Russ).

INFORMATION ABOUT AUTHORS

Pavlova Svetlana Anatol'evna — Doctor of Biological Sciences, professor of the Department of environmental management and environmental protection of the Russian Presidential Academy of National Economy and Public Administration (RANEPA)

For citation:

Pavlova SA. Radiating pathology in agricultural animals with a diseased thyroid gland. *RUDN Journal of Agronomy and Animal Industries*, 2018, 13 (4), 303—316. doi: 10.22363/2312-797X-2018-13-4-303-316.

DOI: 10.22363/2312-797X-2018-13-4-303-316

РАДИАЦИОННАЯ ПАТОЛОГИЯ У СЕЛЬСКОХОЗЯЙСТВЕННЫХ ЖИВОТНЫХ С ПОРАЖЕННОЙ ЩИТОВИДНОЙ ЖЕЛЕЗОЙ

С.А. Павлова

Российская Академия народного хозяйства и государственной службы
при Президенте Российской Федерации
Москва, 119571, Россия
s_pavlova@mail.ru

Радиоактивный йод присутствует в атмосферных выпадениях в первые часы аварийных выбросов на АЭС. Он вызывает поражения щитовидной железы различной степени тяжести. В результате поражения радиоактивным йодом в щитовидной железе развиваются патологические изменения, которые могут влиять на продуктивные показатели и воспроизводство сельскохозяйственных животных. Физиологические изменения диагностируют и у животных, которые не получают в достаточном количестве соединения йода с кормом или водой. Это может привести к патологии щитовидной железы.

Экспериментально определено, что малые поглощенные щитовидной железой дозы радиации вызывают повышение ее активности, а большие — угнетение активности и разрушение паренхимы органа, что характерно для хронической лучевой болезни II и III степени тяжести.

Хроническая лучевая болезнь, которая диагностируется у овец при поражении Йодом-131, развивается медленно, ранняя диагностика степени тяжести затруднена. На основе экспериментальных данных установлено, что для средней степени тяжести лучевой болезни отмечается снижение шерстной продуктивности и плодовитости и выживаемости потомства.

Системный анализ данных по радиоактивно загрязненным хозяйствам позволил выявить степень тяжести радиационной патологии у сельскохозяйственных животных животноводческих комплексов. Исследования патологии щитовидной железы следует проводить на основе методов

структурного моделирования и данных, получаемых экспериментально. Анализ сравнения патологических эффектов позволяет систематизировать информацию и использовать ее в научно-практических целях. На основе проведенных исследований установлено, что для оценки состояния эндокринной системы сельскохозяйственных животных, находящихся на загрязненной радионуклидами территории, необходимо учитывать сезонные и возрастные особенности по возрастным группам и с учетом действующей дозы. Разработка и практическое использование методов моделирования позволяет не только систематизировать собранную информацию, но и спрогнозировать ситуацию в хозяйствах, подвергнутых радиоактивному загрязнению.

Ключевые слова: щитовидная железа, радиационная патология, сельскохозяйственные животные, моделирование

БИБЛИОГРАФИЧЕСКИЙ СПИСОК

1. Оценка последствий радиационного поражения овец и ведение овцеводства в условиях радиоактивного загрязнения территории // Методические рекомендации для слушателей ФПК по курсу ГО. Казань, 1984. 30 с.
2. *Ильенко А.И.* Проблемы и задачи радиэкологии животных. М.: Наука, 1980. 256 с.
3. Проблемы сельскохозяйственной радиологии: сборник научных трудов / под ред. Б.С. Пристера. Киев: УкрНИИСХР, 1996. № 4. 240 с.
4. *Ильин Л.А.* Радиоактивный йод в проблеме радиационной безопасности. М.: Атомиздат, 1972. 272 с.
5. *Обатуров Г.М.* Биофизические модели радиобиологических эффектов. М.: Энергоатомиздат, 1987. 152 с.
6. *Киришин В.А., Бобрышев К.П., Бударков В.А., Гусарова М.Л., Жуков Е.Г., Зеленев Ю.Н.* Радиационные эффекты у животных. М.: МГАВМиБ, 1999. 196 с.
7. *Ильязов Р.Г., Алексахин Р.М., Корнеев Н.А., Сироткин А.Н.* Радиэкологические аспекты животноводства (последствия и контрмеры после катастрофы на Чернобыльской АЭС). Гомель: Полеспечать, 1996. 179 с.
8. *Романов Г.Н.* Радиэкологические оценки последствий аварии на Чернобыльской АЭС для территории 30-км зоны и УССР // Отчет о НИР. 1987.
9. *Сироткин А.Н., Ильязов Р.Г.* Радиэкология сельскохозяйственных животных. Казань: ФЭН, 2000. 384 с.
10. *Лоцилов Н.А.* Проблемы сельскохозяйственной радиологии // Сборник научных трудов. Киев: УИНТЭИ и УНИИСР, 1992. 204 с.

Для цитирования:

Павлова С.А. Радиационная патология у сельскохозяйственных животных с пораженной щитовидной железой // *Вестник Российского университета дружбы народов. Серия: Агрономия и животноводство*. 2018. Т. 13. № 4. С. 303—316. doi: 10.22363/2312-797X-2018-13-4-303-316.